Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Navy	Date: February 2016
Appropriation/Budget Activity 1319: *Research, Development, Test & Evaluation, Navy I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602123N *I Force Protection Applied Res*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	0.000	159.556	178.616	158.745	-	158.745	164.678	156.832	161.216	163.361	Continuing	Continuing
0000: *Force Protection Applied Res*	0.000	136.125	154.916	158.745	-	158.745	164.678	156.832	161.216	163.361	Continuing	Continuing
9999: *Congressional Adds*	0.000	23.431	23.700	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	47.131

A. Mission Description and Budget Item Justification

The efforts described in this program element (PE) are based on investment directions as defined in the Naval S&T Strategic Plan approved by the S&T Corporate Board (20 Jan 2015). This strategy is based on needs and capabilities from Navy and Marine Corps guidance and input from the Naval Research Enterprise (NRE) stakeholders (including the Naval enterprises, the combatant commands, the Chief of Naval Operations (CNO), and Headquarters Marine Corps). It provides the vision and key objectives for the essential science and technology efforts that will enable the continued supremacy of U.S. Naval forces in the 21st century. The Strategy focuses and aligns Naval S&T with Naval missions and future capability needs that address the complex challenges presented by both rising peer competitors and irregular/asymmetric warfare.

This PE addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability. This is accomplished by improvements in platform offensive performance, stealth, and self-defense.

Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE.

B. Program Change Summary ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	163.660	154.963	146.800	-	146.800
Current President's Budget	159.556	178.616	158.745	-	158.745
Total Adjustments	-4.104	23.653	11.945	-	11.945
• Congressional General Reductions	-	-0.047			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	23.700			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.331	0.000			
• SBIR/STTR Transfer	-3.773	0.000			
• Program Adjustments	0.000	0.000	14.480	-	14.480

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• Rate/Misc Adjustments	0.000	0.000	-2.535	-	-2.535

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2015	FY 2016
Project: 9999: *Congressional Adds*		
Congressional Add: *Program Increase*	4.061	3.700
Congressional Add: *Alternative Energy Research*	19.370	20.000
Congressional Add Subtotals for Project: 9999	23.431	23.700
Congressional Add Totals for all Projects	23.431	23.700

Change Summary Explanation

Technical: Not applicable.

Schedule: Not applicable.

Exhibit R-2A, RDT&E Project Justification: PB 2017 Navy			Date: February 2016
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COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
0000: *Force Protection Applied Res*	0.000	136.125	154.916	158.745	-	158.745	164.678	156.832	161.216	163.361	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project addresses applied research associated with providing the capability of Platform and Force Protection for the U.S. Navy. It supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial, and air) and the protection of those platforms. The goal is to provide the ability to win or avoid engagements with other platforms or weapons and, in the event of engagement, to resist and control damage while preserving operational capability. Within the Naval Transformational Roadmap, this investment directly supports the Theater Air and Missile Defense transformational capability required by Sea Shield and the Ship to Objective Maneuver key transformational capability by virtue of improvements in platform offensive performance, stealth, and self-defense.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Title: AIRCRAFT TECHNOLOGY	52.311	68.537	65.452	0.000	65.452
Description: The Aircraft Technology activity develops technologies for reduced observables technology and enhanced capability of naval aviation aircraft platforms in terms of mission effectiveness, platform range, responsiveness, survivability, observability, readiness, safety and life cycle cost. It also develops new Naval air vehicle concepts and high impact, saleable naval air vehicle technologies, such as - autonomous air vehicle command and control, helicopter and tilt rotorsystems, aerodynamics, propulsion systems, materials, structures and flight controls for future and legacy air vehicles. Variable Cycle Advanced Technology (VCAT) will identify and mature critical, relevant variable/adaptive cycle propulsion system technologies for the next generation carrier-based Tactical Aircraft (TACAIR)/Intelligence, Surveillance and Reconnaissance(ISR) systems. Autonomous Aerial Cargo/Utility System (AACUS) will develop advanced autonomous capabilities to enable rapid resupply of distributed forces in the short term. The Sea-Based Aviation National Naval Responsibility (SBA NNR) Structures and Materials program will develop the next generation structural capability and material response science for aircraft technology in fixed and rotary wing, manned and unmanned airframe technology to achieve reduced weight, increased durability, strength, streamlined manufacturability, reduced life-cycle cost and maintenance/readiness gaps improvements. Program payoffs include increased availability/readiness, reduced sustainment requirements, fatigue/loads life enhancement, reduced weight and improved range, and advanced prognostics design tools.					

Exhibit R-2A, RDT&E Project Justification: PB 2017 Navy		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
These efforts addresses unique attributes to propulsion and power technologies for Naval Aviation, as well as those having higher importance to Naval Aviation and some that are more pervasive to all of military aviation. Related basic research efforts are addressed under 0601153N. The funding increase from FY 2015 to FY 2016 is due to the initiation of the joint Tern program and an increase in AACUS activities as the program enters phase 3. The funding decrease from FY 2016 to FY 2017 is due to maturation of AACUS technology applied research effort. ***FY 2015 Accomplishments:*** -Continue new efforts on high confidence/Safe Autonomous Control in naval environments and on supervisory control of decentralized heterogeneous UAS. -Continue SBA NNR related projects in Virtual Ship/Aircraft Dynamic Interface, Manned/Unmanned Handling Qualities and Control, Automated Deck Operations, High Lift Aerodynamics and Vertical/Short Takeoff and Landing (V/STOL) Operations. -Continue applied research efforts under the Sea-Based Aviation National Naval Responsibility Propulsion thrust area. -Continue development of rotorcraft/VTOL systems automated launch and recovery technology. -Continue mixed-mode mechanical/environmental failure prediction research. -Continue advanced composite durability technology. -Continue material degradation risk prediction and operational environment-driven materials selection methods. -Continue demonstration of initial core software, sensor, air vehicle, and capability applications for Autonomous Aerial Cargo/Utility System (AACUS). -Continue the advanced technology demonstration portion of the Variable Cycle Advanced Technology (VCAT) Program. Critical technology development efforts will begin with major engine manufactures and system contractors to develop/mature the highest priority, long-lead propulsion system technologies, including variable/ adaptive cycle engine components, for next generation carrier-based TACAIR/ISR systems. - Continue VCAT Phase I variable cycle engine/propulsion subsystem technology development efforts through completion. - Continue to explore and evaluate future aircraft concepts and their associated enabling technologies. - Continue development of survivability/reduced observables technology. Metrics are classified.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Initiate new efforts on safe-perception based autonomous control in complex naval environments and on autonomy to support combined unmanned and manned air systems/units. - Initiate airplane launch and recovery component and subsystem technology developments to enable medium size long endurance, long range UAVs to be launched and recovered on short deck ships. ***FY 2016 Plans:*** - Continue all efforts of FY 2015, unless noted as completed above. ***FY 2017 Base Plans:*** - Continue all efforts of FY 2016, unless noted as completed above. ***FY 2017 OCO Plans:*** N/A					
Title: FLEET FORCE PROTECTION AND DEFENSE AGAINST UNDERSEA THREATS	2.507	2.532	2.527	0.000	2.527
Description: Fleet Force Protection and Defense against Undersea Threats efforts include applied research for complementary sensor and processing technologies for platform protection. Current small platforms (both surface and airborne) have little to no situational awareness (SA) or self-protection against air, surface, and asymmetric threats. A goal of this activity is to provide these platforms with effective self-protection. The technology areas specific to platform protection will develop individual, multispectral electro-optical (EO), infrared (IR), radio frequency (RF), electro-magnetic (EM), visual and acoustic or chemical sensors/ biosensors and associated processing. To defend platforms from current and advanced threats in at-sea littoral environments and in port, these technologies must improve multispectral detection and distribution of specific threat information. ***FY 2015 Accomplishments:*** Sensors & Associated Processing: -Continued Electrochemical sensors for the distributed, remote detection of explosives -Continued efforts in biomimetic sonar systems for operation in air and aquatic environments based on bat echolocation neurophysiology and information processing algorithms. -Continued efforts in biomimetic signal processing: panoramic periscope for submarines and temporal pattern recognition for Systems for Security Breaching Noise Detection. -Continued efforts in bioinspired quiet, efficient and maneuverable self-propelled line array using high-lift propulsors based on insect biomechanics. -Continued studies to develop catalytic activity profile of bioactive coatings against chemical agents.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
-Continued design and initiated fabrication of coatings to degrade both, chemical and biological agents. -Continued efforts to design microfabricated system for 3-color fluorescence measurements using integrated waveguides. -Continued effort to develop new, highly selective, preferential oxidation catalysts for the generation of power from the reformate gas purification process. -Continued effort to develop aspheric gradient index optics. - Completed development of distributed environmental microsensors for analyte dectection. - Completed a capability to examine via analysis and modeling protytype electronic attach concepts against radars in expanded spectral bands. - Initiated effort to develop an implosion-resistant hydrogen storage technology for use in undersea fuel cells. - Initiated development of wide area standoff detection of explosives ***FY 2016 Plans:*** Sensors & Associated Processing: - Continue all efforts of FY 2015, unless noted as completed above. ***FY 2017 Base Plans:*** Sensors & Associated Processing: - Continue all efforts of FY 2016, unless noted as completed above. ***FY 2017 OCO Plans:*** N/A					
Title: ADVANCED ENERGETICS ***Description:*** Advanced Energetics efforts address technology development to provide substantial improvements in energetic material systems and subsystems, primarily in terms of performance, but also addressing safety, reliability, and affordability concerns. Goals include: advanced energetic materials for warheads, propellants, and reactive material based subsystems for both defensive and offensive applications. Efforts include: development of new fuels, oxidizers, explosive ingredients and formulations; and reliable simulation tools and diagnostics to develop and design superior-performance, and/or reduced-vulnerability systems tailored to specific warfighter missions. ***FY 2015 Accomplishments:*** - Continued process research and development of Ammonium Nitrotetrazolate-2N-oxide (AONT).	5.052	5.408	5.339	0.000	5.339

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Continue the processing optimization design of material compositions for Reactive Material explosive fragment applications. - Continued optimization and refinement studies of Poly NitratoOxetane (3-PNO) process for solid rocket motor propellants. - Continued the development of a reliable chemical scale-up and material specification process techniques. - Continued ultra-high density reactive material investigations (13 - 15 grams/cc) for the next generation reactive material warhead material (formulations, material properties, target interaction, letality models, and experiments). - Continued Advanced Energetics research in development and evaluation of advanced explosive/propellant/ reactive ingredients and formulations for the next generation higher performing systems. - Continued non-traditional energy conversion studies with columbic and cluster material investigations. - Continued Advanced Energetics research in development of advanced directed hydro-reactive material warhead concepts to enhance performance of undersea warheads. - Continued proof of concept efforts to develop insensitive explosives, propellants, and munitions without compromising performance. This work involves development of high quality, small particle energetic ingredients, novel processing techniques, and advanced energy conversion concepts; and involves both theoretical and experimental efforts. - Continued Advanced Energetics research in advanced multiphase blast concepts employing dense metalized explosives to enhance performance of air and underwater blast warheads. - Continued Advanced Energetics research in development and diagnostics of novel energy conversion concepts to enhance performance, more efficiently exploit available energy, and more effectively couple energy to target for air, surface, and underwater warhead application - Continued research in technology development for the next generation reactive material warhead concepts formulations, material properties, and energy release experiments for highly reactive materials, high density reactive materials and novel reactive structural materials. Transition application specific target interaction, lethality modeling and ordnance specific experiments and demonstrations to Electromagnetic Rail Gun, PE 0603114N. - Continued development and evaluation of energetic ingredients and formulations for next generation higher performance applications. Concluded scale-up development and testing. - Continued the processing optimization design of material compositions for Reactive Material explosive fragment applications. - Continued ultra-high density reactive material investigations (13 - 15 grams/cc) for the next generation reactive material warhead material (formulations, material properties, target interaction, lethality models, and experiments)					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Continued the development of a reliable chemical scale-up and material specification process techniques. - Completed Studies on MTX-1 (1-[(2E)-3-(1H-tetrazol-5-yl)triaz-2-en-1-ylidene] methanediamine), an additive to percussion primers. - Completed Advanced Energetics research in development of advanced directed hydro-reactive material warhead concepts to enhance performance of undersea warheads. - Completed process optimization of Ammonium Tetrakis (3,5-Dinitro-1,2,4-Triazolyl) Borate (ATDTB). - Initiated research on new caged nitramines - Initiated process research and development of 1,1'-Diamino4,4',5'5'-Tetranitro-2,2'-Biimidiazole (DATNBI) - Initiated process research and development of 1-Fluoro-4,5-Dinitroimidazole. ***FY 2016 Plans:*** - Continue all efforts of FY 2015, unless noted as complete above. ***FY 2017 Base Plans:*** - Continue all efforts of FY 2016, unless noted as complete above. - Initiate electric on/off propulsion system studies for advanced solid and liquid rocket compositions - Initiate process research and development of Dihydroxylammonium Dinitramino Azoxy Furazan (DDAF) - Initiate process research and development of Ammonium-3,4,5,-trinitropyrazolate (ATNPz) - Complete ultra-high density reactive material investigations (13 - 15 grams/cc) for the next generation reactive material warhead material (formulations, material properties, target interaction, lethality models, and experiments) - Complete process research and development of 1,1'-Diamino4,4',5'5'-Tetranitro-2,2'-Biimidiazole (DATNBI) - Complete process research and development of 1-Fluoro-4,5-Dinitroimidazole. ***FY 2017 OCO Plans:*** N/A					
Title: SURFACE SHIP & SUBMARINE HULL MECHANICAL & ELECTRICAL (HM&E) ***Description:*** Efforts include: signature reduction, hull life assurance, hydromechanics, distributed control for automated survivability (includes damage control), and advanced naval power systems. Signature reduction addresses electromagnetic, infrared, and acoustic signature tailoring, both topside and underwater.	71.788	73.888	80.882	0.000	80.882

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Hull life assurance addresses development of new structural system approaches for surface ships and submarines, including the management of weapons effects to control structural damage and the improvement of structural materials. Hydromechanics addresses hydrodynamic technologies, including the signature aspects of the hull-propulsor interaction and maneuvering. Distributed intelligence for automated survivability addresses both the basic technology of automating machinery control systems, as well as, distributed control of systems utilizing autonomy for mission context based reconfiguration. Unmanned Sea Surface Vehicle applied research includes short-term motion forecasting for recovery of USSVs on a host ship in higher sea states and determination of slamming loads on high-speed planing hulls for structural weight reduction. Advanced naval power systems efforts address electrical and auxiliary system and component technology to provide improvement in energy and power density, operating efficiency and recoverability from casualties. Advanced Naval Power efforts include: developing technologies to improve warfighting capability with more energy efficient systems; mitigate adverse impacts of alternative fuel on Naval platforms and equipment; and utilizing the Electric Ship Research and Development Consortium (ESRDC) efforts to develop modeling and simulation tools to provide critical design & operational capabilities for the all-electric ship program, accelerate development and demonstration of technologies, reduce risk of new technology insertion and address the national shortage of electrical power engineers. Long Endurance UUV technologies will deliver to the Office of Naval Research modular fuel cell systems for UUVs, including practical systems demonstrations, and a path forward for future developments. It will also keep the US Navy at the forefront of advanced electric propulsion technologies. The funding increase from FY 2015 to FY 2016 is due to the initiation of a new Leap Ahead effort called Medium Displacement Unmanned Surface Vehicle (MDUSV) program.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
The funding increase from FY 2016 to FY 2017 is due to the ramping up of the MDUSV program and the Applied Research Challenge (ARC) effort. ***FY 2015 Accomplishments:*** Survivable Platforms - Reduced Signatures: - Continued advanced numerical acoustic codes (and gridding methods for those codes) for submarines. - Continued Alternating Current (AC) propagation experiments. - Continued the next generation Infrared Electro-Optic Visual (IR/EO/VIS) model for surface ships by development of mitigation strategy supporting low observable infrared platforms, development of supporting physics, and prototype measurement techniques. - Continued development of quiet control surface design tool based on control surface flow noise studies. - Continued IR and radar detectability prediction capability. - Continued surface ship super-conductive degaussing with laboratory demonstration loop for Electromagnetic (EM) field accuracy measurements and control methods. - Continued testing on Advanced Electric Ship Demonstrator (AESD) to assess energy propagation and acoustic radiation mechanisms and to develop mitigation concepts for surface ships. - Continued Improved Corrosion Related Magnetic (CRM) Field Prediction Model to design compensation systems to reduce ship's CRM signature. - Continued assessment of ship bi-static Radar Cross Section (RCS). - Continued large-scale tests on AESD to develop signature prediction and design tools for surface ship incorporating a variety of propulsion technologies including external podded propulsion. - Continued experimental effort to characterize electric drive motor signature mechanisms and verify modeling and simulation approaches for signature prediction. - Continued development of modeling methods and noise control concepts for modular/reconfigurable submarine architectures. - Continued investigation into hull treatment concepts for acoustic signature/vibration control for surface ships. - Continued development of signature modeling approaches for electric actuation and alternate electric drive system architectures. - Continue development of Low Probability Intercept (LPI) technologies for surface ship emissions including communication, navigation, electronic warfare, and combat systems. - Continued advanced EM modeling tools development and validation. - Continued modeling of hydroacoustics of turbulence-propulsor interaction.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Continue joint effort with UK/MoD on adhesively joined aluminum in lieu of welding of marine structures and thus reduce cost. - Continued joint effort with the Netherland Royal Navy (NLRN) on adhesive joined composite to metals in lieu of bolting of marine structures and thus reduce cost for topside structures. - Continued efforts on shock mitigation and shock diversion for ship hulls to reduce cost of machinery mounts and equipment, based on successful results from the Explosion Resistant Coatings (ERC) helmets for protection against Traumatic Brain Injury (TBI) - Continued utilization of condition-based maintenance systems for platform underwater signature assessment. - Continued development of signature monitoring and management capability of a surface ship propulsion system for underwater acoustic signatures. - Continued development of global optimization of damped structures. - Continued development of non-intrusive sensing method to measure component acoustic signatures. - Continued to develop improved processing techniques for acoustics experiments. - Continued development of a prediction and monitoring tool for underwater signatures. - Completed mmWave Signatures measurement to identify key signature characteristics. - Completed IR assessment of two advanced treatments. - Completed first of a series of IR validation experiments and critical sensitivity analysis. - Completed development of advanced RF metamaterials for platform signature control. - Completed next generation deckhouse integration technology development. Survivable Platforms - Hull Life Assurance: - Continue efforts on combinations of highly rate-sensitive materials through experiment and modeling for extreme hyper velocity threat conditions. - Continued development of global surface wave measurement capability for ship models. - Continued Dynamic Behavior of Composite Ship Structures (DYCOSS) (joint effort with Dutch Navy). - Continued development of structural analysis codes describing failure mechanism of sandwich composites. - Continued Explosion Resistant Coatings (ERC) effort, providing US input to trilateral agreement with UK and Australia. - Continued composite and composite-metal hull performance characterization and testing including structural loading, thermal stress and signatures. - Continued effort on an advanced class of polymers as a follow-on to current ERC for application against advanced threats. - Continued Payload Implosion and Platform Damage Avoidance efforts.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Continued development of advanced analytical, numerical and experimental methods in support of platform signature reduction. - Continued effort on exploitation of polymers for the deflection and dissipation of shock wave impact on ship and submarine hull structures. - Continued development of lightweight low-cost protection system for specific platforms for protection against specific large threats). - Continued development of lightweight protection system for vehicles (MTVR) for protection against specific small arms and IEDs for the Explosion Resistant Coatings (ERC) program. - Continued Ship modifications using blisters for application to DDG51 Flight III to gain larger displacement for AMDR and at the same time achieve higher fuel efficiency. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continued development of modeling and simulation methods for robust design and virtual testing of integration of shipboard auxiliary systems including their control systems. - Continued research into advanced HM&E system reconfiguration approaches, including agent-based control systems and algorithms, and model-based reasoning. - Continued demonstration of Genetic Algorithm(s) for determining optimal distributed system control strategy. - Continued development of Survivability Analysis Algorithms Operable on a Total Ship Modeling Environment. - Continued the transition of the small scale hardware-in-the-loop demonstrator to the academic community for challenge problem formulation. - Continued demonstration of the developed model based reasoning control algorithms on full scale hardware test beds. - Continued development of underwater signature modeling. Advanced Platforms - Advanced Platform Concepts and Designs: - Continued validation of asymmetric hull forms with experimental data. - Continued development of analytical models to further define submarine modular hull concepts. - Continued development of reliability based design and structural analysis code development. - Continued development design tools for integrated antenna and composite topside. - Continued circulation control analysis for three-dimensional flow effects. - Continued aperstructures microwave communication system. - Continued concept for Ultra High Frequency (UHF)/Very High Frequency (VHF) aperstructures opportunistic array (Advanced Hull-form Inshore Demonstrator - AHFID).					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Continued development of methods for determining reliability and vulnerability of aluminum ship structures. - Continued large scale demonstration efforts of advanced mitigation technologies. Advanced Platforms - Hydromechanics: - Continued experimental database/computational tools development for extreme submarine maneuvers (e.g., crashback). - Continued the validation of circulation control and advanced control surfaces with experiments. - Continued to investigate improved maneuvering simulation capability for submarines. - Continued numerical prediction method(s)of waterjet cavitation. - Continued modeling and simulation of rough-wall boundary layer noise. - Continued development of podded propulsor design/analysis tools. - Continued prediction and validation of damaged stability and capsize. - Continued non-body-of-revolution tool development for advanced submarine configurations. - Continued the multi-platform interaction analysis and tool development. - Continued modeling of performance of composite propellers in extreme maneuvers. - Continued cavitation erosion modeling on compliant surface. - Completed waterjet efforts, including two-phase waterjet development and RANS code development and validation efforts. - Initiated a research on design/analysis methods of ice-capable propellers. - Initiated a research on the effect of propeller on bubbly flows. Advanced Naval Power Systems: - Continued effort to integrate front-and back diamond with high current GaN power switches for advanced thermal management. - Continued SIC GTO thyristor designs and testing apparatus to increase the turn-on di/dt and reliability for pulsed power. - Continued demonstration of dynamic stability of an advanced intelligent, reconfigurable, solid-state-based, zonai-electrical-power system that reconfigures within 10 milliseconds.- Continued designing software for the system manager for the Universal Control Architecture (UCA). - Continued development of thermal management technology for shipboard power distribution. - Continued investigation of potential applications of silicon-carbide in future high voltage and high power applications.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Continued improvements in electrical component and device technology allowing a reduction in motor propulsion and motor controllers weight and volume. - Continued development of technologies to support dynamic reconfiguration of shipboard systems under conditions of stressing scenarios and/or system degradation. - Continued studies of alternative cooling systems for future shipboard radar systems. - Continued control surface actuator project focused on the technologies needed to define the design space for control surface actuators supporting submarines. - Continued development of automated HVAC system architectures for future Naval platforms. - Continued ship service fuel cell development. - Continued program to develop and demonstrate 3 - 50 kW class solid oxide fuel cell onboard mobile power generation capabilities having compatibility with future logistics fuels to enable rapid recharge of batteries and direct power for C4ISR equipment. - Continued analytical model and reduced scale component development of power conversion technologies for multi-function motor drives, bi-directional power conversion modules, and power management controllers focusing on closing technology gaps associated with Alternative Integrated Power System (IPS) Architectures. - Continued studies of advanced heating, ventilation, and air-conditioning architectures, including studies of alternative (nonvapor-compression) refrigeration systems and concepts for waste heat reuse, to enhance ship cooling and provide thermal energy storage. - Continued research into the development of fuel chemistries, materials, and energy conversion technologies for optimal performance in Naval power systems. - Continued development of robotic Hull BUG and coating technologies to reduce hull biofouling over current Navy operating conditions which will reduce drag and provide significant power/fuel/cost savings. - Continued development of fuel cell components needed to make robust, compact, lightweight fuel cell systems for use in unmanned vehicles. - Continued development of low cost, light weight, flexible solar cells. - Initiated effort to make significant impact in high voltage power electronics technology to enable compact power converters, medium voltage distributed power architectures, new weapons and sensor systems for Navy and Marine applications. Surface Ship & Submarine HM&E Applied Research: - Continued efforts to implement the results from hybrid composite blisters /appendages and their effect on ship drag resistance and fuel saving performance, motion and stability in ship models to verify computations and adapt shapes of appendages.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Continued to increase emphasis of the Science Advisor engagement within the joint S&T community across DOD, which will focus on addressing the operational and strategic needs of the Fleet. - Continued applied research into short-term motion forecasting for recovery in higher sea states. - Continued applied research into determination of slamming loads on high-speed planing hulls for structural weight reduction. - Initiated the ONR Applied Research Challenge (ARC) to stimulate new, high-risk applied research projects in areas not currently addressed by the current ONR core applied research programs. - Initiated efforts to implement the results from hybrid composite blisters/appendages and their effect on ship drag resistance and fuel saving performance, motion and stability in ship models to verify computations and adapt shapes of appendages. Advanced ASW Surveillance: - Initiated development of Long Endurance UUV technologies. Counter Improvised Explosive Devices: - Continued efforts to expand counter-improvised explosive devices (C-IED) enhancement to support urgent operational needs. - Continued research to analyze and understand enemy threat organizations and networks (both cultural networks and IT networks) - Continued research in directed energy weapons with the goal of reducing size, weight, and power requirements for systems in the detection and neutralization of IEDs. - Continued research in the mitigation of CIED effects (blast, blunt trauma, ballistics) on personnel. - Completed effort to develop transparent armor using flawless glass. - Completed effort on the studies of antennas for high powered microwaves and radio frequency applications. - Initiated research in Route Reconnaissance and Clearance methodologies to provide standoff detection, neutralization, and marking of buried and surface laid, on and off route, pressure plate, command wire and radio frequency initiated explosive obstacles using directed energy and mechanical means on autonomous or semi autonomous platforms Signature reduction - Initiated study of graphene based magnetic tunnel junctions					
FY 2016 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2017 Navy		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Survivable Platforms - Reduced Signatures: - Continue all efforts of FY 2015. - Initiate planning at-sea experiments to determine principal offenders for small craft airborne and underwater acoustic signatures. - Initiate development of high fidelity airborne acoustic propagation and detection model for surfzone and littoral detection of small craft. - Initiate development of radar absorbing ballistic composite materials for small craft hull and superstructures. Survivable Platforms - Hull Life Assurance: - Continue all efforts of FY 2015, unless noted as completed above. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continue all efforts of FY 2015, unless noted as completed above. Advanced Platforms - Advanced Platform Concepts and Designs: - Continue all efforts of FY 2015, unless noted as completed above. - Initiate activities in understanding platform modification for greater access in polar environments. Advanced Platforms - Hydromechanics: - Continue all efforts of FY 2015, unless noted as completed above. - Initiate efforts to model platform performance and stability as well as propulsor performance in ice environments. Advanced Naval Power Systems: - Continue all efforts of FY 2015, unless noted as completed above. - Complete effort to integrate front- and back-side diamond with high current GaN power switches for advanced thermal management. - Complete SiC GTO thyristor designs and testing apparatus to increase the turn-on dI/dt and reliability of SiC GTOs for pulsed power. Surface Ship & Submarine HM&E Applied Research: - Continue all efforts of FY 2015, unless noted as completed above.					

Exhibit R-2A, RDT&E Project Justification: PB 2017 Navy		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Initiate Medium Displacement Unmanned Surface Vessel (MDUSV) program applied research supporting a highly autonomous control and payloads supporting mine warfare, anti-submarine warfare and electronic warfare. Counter Improvised Explosive Devices: - Continue all other efforts of FY 2015, unless noted as completed above. Applied Research Challenge (ARC): - Continue all base program efforts initiated in FY 2015 including network information sciences, long-range high-resolution imaging, ocean surface scatter in RF propagation, wake measurement technologies, thermal management systems, high power control modules for ship application, decision support / uncertainty analysis for operational environments, and reactive composite materials. Signature reduction - Continue all efforts of 2015, unless noted as completed above.					
FY 2017 Base Plans: Survivable Platforms - Reduced Signatures: - Continue all efforts of FY 2016, unless noted as completed above. - Complete large scale tests on AESD to develop signature prediction and design tools for surface ship incorporating a variety of propulsion technologies including external podded propulsion - Complete investigation into hull treatment concepts for acoustic signature/vibration control for surface ships. - Complete development of signature modeling approaches for electric actuation and alternate electric drive system architectures. - Complete utilization of condition-based maintenance systems for platform underwater signature assessment. - Complete development of non-intrusive sensing method to measure component acoustic signatures. Survivable Platforms - Hull Life Assurance: - Continue all efforts of FY 2016, unless noted as completed above. - Complete Explosion Resistant Coatings (ERC) effort, providing US input to trilateral agreement with UK and Australia - Complete composite and composite-metal hull performance characterization and testing including structural loading, thermal stress and signatures.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Initiate Explosion Resistant Coatings (ERC) effort with TTCP countries. - Initiate development of testing methodologies to validate computational codes and constitutive models for glassy materials. Survivable Platforms - Distributed Intelligence for Automated Survivability: - Continue all efforts of FY 2016, unless noted as completed above. Advanced Platforms - Advanced Platform Concepts and Designs: - Continue all efforts of FY 2016, unless noted as completed above. - Initiate activities in understanding platform modification for greater access in polar environments. Advanced Platforms - Hydromechanics: - Continue all efforts of FY 2016, unless noted as completed above. - Initiate efforts to model platform performance and stability as well as propulsor performance in ice environments. Advanced Naval Power Systems: - Continue all efforts of FY 2016, unless noted as completed above. - Complete effort to integrate front- and back-side diamond with high current GaN power switches for advanced thermal management. - Complete SiC GTO thyristor designs and testing apparatus to increase the turn-on dI/dt and reliability of SiC GTOs for pulsed power. - Complete development of robotic Hull BUG and coating technologies to reduce hull biofouling over current Navy operating conditions which will reduce drag and provide significant power/fuel/cost savings. Surface Ship & Submarine HM&E Applied Research: - Continue all efforts of FY 2016, unless noted as completed above. Counter Improvised Explosive Devices: - Continue all efforts of FY 2016, unless noted as completed above. - Complete efforts to expand counter-improvised explosive devices (C-IED) enhancement to support urgent operational needs.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Complete research to analyze and understand enemy threat organizations and networks (both cultural networks and IT networks) - Initiate research and development of modular, reconfigurable, integrated multi-modal stand-off detection and neutralization of explosive hazard (IED & Mines) system. Applied Research Challenge (ARC): - Continue all base program efforts initiated in FY 2016 including network information sciences, long-range high-resolution imaging, ocean surface scatter in RF propagation, wake measurement technologies, thermal management systems, high power control modules for ship application, decision support/uncertainty analysis for operational environments, and reactive composite materials. ***FY 2017 OCO Plans:*** N/A					
Title: NAVAL RESEARCH ENTERPRISE	4.467	4.551	4.545	0.000	4.545
Description: The IAR R2 activity was stood up in FY 2013 as the Naval Research Enterprise (NRE) to consolidate all NRE related IAR investments. Projects funded in this R2 Activity are intended to be approximately 2-3 years in length. Based on historical trends approximately 30% of these projects will turn over each year. The Naval Research Enterprise (NRE) encompasses the Independent Applied Research (IAR) efforts focused on solving a wide range of Naval Science and Technology (S&T) fleet issues utilizing unique Naval Warfare Center (WC) laboratory capabilities. Efforts under this activity address the full spectrum of the DON S&T Strategic Plan technology using focus areas which engage Naval aviation, sea surface, undersea, space, weapons, communication, information, and human systems. The IAR Program provides participating WCs with in-house funding for applied research to support the execution of their assigned missions by: -Developing and maintaining a cadre of active researchers who can distill and extend results from worldwide research and apply them to solve Naval problems. -Promoting the hiring and development of talented new scientists and engineers (S&E) with the insurance of proper mentoring with senior personnel. -Encouraging collaboration with universities, private industry, and other Navy and Department of Defense laboratories. Funded projects are chosen through rigorous internal competition by each WC's selection committee and typically last two to three years. IAR projects are generally designed to promote investment in high-risk/high-					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
payoff research and also allow young S&Es to manage Navy relevant research projects. A limited number of successful efforts developed under the In-House Laboratory Independent Research (ILIR) basic research Program Element 0601152N are matured and further developed under the IAR program with the goal of transitioning these technologies to the warfighter. ***FY 2015 Accomplishments:*** - Continued research for the repair and repair process of Navy aircraft and ship alloys such as titanium and high-strength low-alloy steels, composites, and metamaterials. - Continued research for highly accurate autonomous unmanned undersea vehicles (UUV) communication and navigation. - Completed research for the repair and repair process of Navy aircraft and ship alloys such as titanium and high-strength low-alloy steels. - Completed research for warfighter performance predictions utilizing cognitive information and other human factors to enhance training experience and outcome. - Completed research on the effects of CMAS (Sand Dust) in Ceramic Matrix Composites (CMCs) to characterize CMAS and CMAS/salt effects in gas-turbine grade engine environments. - Completed research on the development and characterization of exploding ink. - Completed research on advanced submarine air purification. - Completed research on large-eddy simulations of advanced propulsion technology for UAV weapon systems. - Completed research on a metamaterial-based buoyant cable antenna with non-uniform loading. - Completed research of a bioluminescence system for submerged vehicles. - Inititated FY 2015 projects. ***FY 2016 Plans:*** - Continue all efforts of 2015, less those noted as completed above. - Complete all two year efforts started in FY 2015 and three year efforts started in FY 2014. Due to the number of efforts in this PE, the programs described herein are representative of the work included in this PE: - Complete research on Bio-inspired Broadband Sonar System for High-resolution Acoustic Imaging Applications. - Complete research on Advanced Infrared Suppressor. - Complete Determining R-45M Prepolymer Characteristics that Optimize Propellant Cure and Mechanical Properties.					

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
- Complete Development of Novel Propellants and Explosives Using Resonant Acoustic Mixing (RAM) Technology. - Complete study of the Electromagnetic Probability-of-effect Assessment Tool (EMPAT) for High-Power HERO/ EMV Test and Evaluation . - Complete Examination of Human Performance Characteristics using Eye-tracking and 3D Motion Capture Gaze Supported Gestures. - Complete research on Extended Object Tracking in Clutter with Exploitation of Doppler Measurements and Multi-Scan Detection Clustering. - Complete Research on Geospatial and Temporal Anomaly Detection using Scalable Cloud-Based Algorithms - Complete Improving Damage Tolerance Thresholds and Energy Absorption Capacities in Laminated Woven Composites using Crimp Imbalance and Crimp Imbalance Gradients - Complete Nondestructive Evaluation (NDE) Enhanced Accelerated Life Testing (ALT). - Complete Synthesis and Characterization of Novel Reactive Materials by Mechanical Alloying. - Complete Smoothed Particle Applied Mechanics research. - Initiate FY 2016 projects. ***FY 2017 Base Plans:*** - Complete FY 2015 IAR projects which were three years in duration. - Continue IAR projects initiated in FY 2016. - Initiate FY 2017 IAR projects that are intended to be approximately three years in length. ***FY 2017 OCO Plans:*** N/A					
Accomplishments/Planned Programs Subtotals	136.125	154.916	158.745	0.000	158.745

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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E. Performance Metrics

This PE supports the development of technologies associated with all naval platforms (surface, subsurface, terrestrial and air) and the protection of those platforms. Each PE Activity has unique goals and metrics, some of which include classified quantitative measurements. Overall metric goals are focused on achieving sufficient improvement in component or system capability such that the 6.2 applied research projects meet the need of or produce a demand for inclusion in advanced technology that may lead to incorporation into acquisition programs or industry products available to acquisition programs. Efforts funded in this PE also include energy programs in support of SECNAV energy goals and efforts in support of the Ohio Replacement program.

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COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
9999: *Congressional Adds*	0.000	23.431	23.700	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	47.131

A. Mission Description and Budget Item Justification

Congressional Interest Items not included in other Projects.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016
Congressional Add: Program Increase	4.061	3.700
FY 2015 Accomplishments: -Continued and expanded on-going competitive award efforts that improve lithium-ion battery safety, including non-flammable electrolytes and safer cell technology, to enable broader adoption for a variety of Navy applications. -Continued and expanded on-going competitive award efforts organo-polymer materials for capacitive energy storage and low-cost photovoltaic materials and devices.		
FY 2016 Plans: -Continue promising energy storage and power generation research that supports the program goal. -Expand the portfolio of materials and architectures to address Naval needs through additional competitive awards.		
Congressional Add: Alternative Energy Research	19.370	20.000
FY 2015 Accomplishments: - Continued microgrid analyses at Naval Facilities in Hawaii to increase energy security for critical infrastructure and to determine capabilities needed for effective base-to-utility interconnect under conditions of high-penetration of renewables. - Commissioned a new hydrogen fueling station at Marine Corp Base Hawaii (MCBH). - Continued heat exchanger material corrosion evaluation and process control evaluations for Ocean Thermal Energy Conversion (OTEC) systems. - Provided Naval Facilities with sea-water air condition (SWAC) cost and performance analysis using new modeling tools. - Continued development of sophisticated hydrodynamic tools for design of high performance, high efficiency hull forms for naval ships and craft. - Continued evaluation of grid frequency control techniques using grid frequency response and battery state-of-charge algorithms for lithium-titanate battery system, demonstrating 40% reduction in frequency variability on grid with high-penetration of wind power, and initiated similar battery approaches at grid locations with high-penetration of photovoltaics.		

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016
- Completed evaluation of General Motors Equinox Fuel Cell Electric Vehicles (FCEVs) for non-tactical vehicle use at Naval Facilities in Hawaii. - Initiated support for wave energy system environmental characterization and modeling. - Initiated hydrogen fuel cells research for operations in harsh environments including unmanned vehicles. - Initiated support for energy storage technologies to mitigate the impact of renewables on grid stability. ***FY 2016 Plans:*** - Continue microgrid analyses at Naval Facilities in Hawaii to increase energy security for critical infrastructure and to determine capabilities needed for effective base-to-utility interconnect under conditions of high-penetration of renewables. - Continue heat exchanger material corrosion evaluation and process control evaluations for Ocean Thermal Energy Conversion (OTEC) systems. - Continue development of sophisticated hydrodynamic tools for design of high performance, high efficiency hull forms for naval ships and craft. - Continue support for wave energy system environmental characterization and modeling. - Continue hydrogen fuel cells research for operations in harsh environments including unmanned vehicles. - Continue support for energy storage technologies to mitigate the impact of renewables on grid stability. - Complete evaluation of grid frequency control techniques using grid frequency response and battery state-of-charge algorithms for lithium-titanate battery system, demonstrating 40% reduction in frequency variability on grid with high-penetration of wind power, and initiated similar battery approaches at grid locations with high-penetration of photovoltaics.		
Congressional Adds Subtotals	23.431	23.700

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

Not applicable.

E. Performance Metrics

Congressional Interest Items not included in other Projects.